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PICKERING NGS 1990 VACUUM BUILDING OUTAGE - FRP COMPONENTS ROUTINE INSPECTION RESULTS/1/

Report No. 90-191-K

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Chemist
Materials Chemistry Section
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ABSTRACT

As part of the AECB licensing requirement, the inspection of FRP components of the dousing system in the Pickering NGS vacuum building was performed in May 1990. In addition to a general visual inspection of all the components, thorough internal and external inspection was carried out on four risers and four downcomers. No evidence of deterioration was detected and the overall system was found to be in excellent condition.

job	file	date	report no.
32-143-553	833.4	September 4, 1990	90-191-K

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EXECUTIVE SUMMARY

PICKERING NGS 1990 VACUUM BUILDING OUTAGE - FRP COMPONENTS ROUTINE INSPECTION RESULTS/1/

G. Gowda

The Pickering NGS vacuum building, which was placed in service in 1971, was first inspected in May 1980. This report describes the results of the second such inspection of the Fiber Reinforced Plastic (FRP) components in the dousing system performed between May 6 and May 28, 1990. The fiber-reinforced plastic components in the vacuum building at the Pickering NGS were found to be in good condition. The stiffening rings installed during the 1980 outage were also in excellent condition including the epoxy adhesive used to attach the ring sections to the risers and downcomers. The hardness readings of all the FRP components were high on the Barcol scale indicating no sign of deterioration.

It is recommended that the fill/drain line going into the spray header H1, where a minor leak was detected, should be reinspected to determine if the leak rate has increased. For the next inspection, downcomers and risers closer to the entrance (upper vacuum chambers) should be selected.

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To: Mr. P. Charlebois
Technical Manager
Pickering NGS

PICKERING NGS 1990 VACUUM BUILDING OUTAGE - FRP COMPONENTS ROUTINE INSPECTION RESULTS/1/

G. Gowda

1.0 INTRODUCTION

The Pickering Vacuum Building, the oldest operating structure of its type within the CANDU system, was placed in service in 1971. The vacuum building was first inspected internally in May, 1980 to evaluate the performance of the structure and other components subjected to the environment found in the building/2/. A second such inspection was carried out from May 6, to May 28, 1990, during which a detailed examination of the Fiber Reinforced Plastic (FRP) dousing system as well as other FRP components was carried out. This report discusses the findings of the Materials Chemistry Section's team who inspected the FRP components, as per the requirements issued by Nuclear Engineering Department (NED)/3/.

2.0 SCOPE

The scope of this routine inspection, which was recommended by NED/3/, includes: visual inspection of all the risers, downcomers, spray headers, and vacuum pipes; hardness measurements; remedial work resulting from the inspection, and inspection after dousing test.

3.0 DOUSING SYSTEM

The dousing system includes the emergency water storage tank (EWST), the pressure actuated water displacement system (two vacuum chambers, 14 risers and 14 downcomers) and the spray headers. The EWST provides water for the dousing spray in the

vacuum building and Figure 1 illustrates the spray system. A rise of pressure inside the vacuum building above 7 Psia will push water from the tank (the tank and the main volume are under the same pressure) up the risers to the upper vacuum chambers and spill into the downcomers which feeds the distribution and spray headers as shown in Figure 2. The numbering system used to identify the downcomers, risers and the spray headers is given Figure 3.

4.0 AREAS INSPECTED

FRP components in the following locations were inspected: Vacuum pipes in the basement, main volume (254'elev), EWST, and on the roof of the vacuum building; Spray headers in the main volume; risers and downcomers in the EWST; and flanges on both the risers and downcomers in the upper vacuum chambers.

Access was provided by way of Genie lifts (Figure 6) in the EWST for visual inspection and hardness measurements (detailed explanation of Barcol Hardness measurements and instrumentation can be found in reference 4) of the risers and the downcomers. Genie lifts were also used to inspect vacuum pipes on the main floor wherever needed. Access to inside of the risers and downcomers was provided by means of a tripod-pulley (Figure 4), and bosun's chair system (Figure 5), supplied by GRIP Safety and Rescue Systems INC, 8481 Keele street, Unit 1, Concord, ONT. Internal and external inspections were conducted in parallel, maintaining radio contact between the inside man and outside man in addition to a third person in the upper chamber. Inside and outside hardness measurements of risers and downcomers were taken at approximately identical locations by shining a light from both inside and outside. A general view of the FRP components in the EWST is shown in Figure 7.

5.0 PERSONNEL INVOLVED IN THE INSPECTIONS

The team members involved in the FRP inspections were: Richard Winn, Richard Cabanus, Dean Beaudry (night shift); Dave Mueller, Gary Fayle, Burt Worth, and Ketan Nanjiani (day shift). R. Winn and B.Worth conducted the internal inspections and Gopala Gowda coordinated the team work. The damaged vacuum pipe flanges on the vacuum building roof was inspected and repaired by R. Winn, G.Gowda and R. Rajagopalan.

6.0 INSPECTION FINDINGS

6.1 Spray Headers

All seven spray headers and lower portions of the downcomers were visually inspected using binoculars from the "cat walk" and were found to be in good condition. The 'T' joints between the downcomers and headers, and 'U' bend portion of the joints were

in excellent condition with no visible water marks. A white spot was found on the downcomer connected to H3. Analysis of a magnified photograph of the patch revealed that it is not related to FRP degradation but a deposit of some sort. There was no evidence of deterioration of the thermoset shims between the headers and supports.

A thorough examination including hardness measurements was carried out on the portions of headers H1, H2, and H3 which were easily accessible from the "cat walk". The general locations of hardness measurements for H1, H2, and H3 were right underneath the stairway, just above the 'C' clamp, and near the spray plates. The hardness readings ranged from 33 to 38 for H3, 36 to 40 for H2, and 35 to 42 for H1 on the Barcol scale (hardness of 20 or higher is acceptable and indicative of the material in excellent condition). The 'C' clamp supports on the headers H1, H2, and H3 were in good condition. The PVC water supply lines on all three headers were in good condition except the fill/drain line (Figure 8) going into the spray header H1 which had a minor leak/5/. The leak rate does not appear to have increased since the 1990 repair. Because of the access problems and the fact that the leak was very small, no repair was attempted at this time.

6.2 Downcomers

A general external visual inspection was carried out on all the downcomers from the EWST floor, and the lower portions of the downcomers below the tank from the walkway in the main volume. All downcomers (Figure 9) were found in excellent condition except for the following: partial delamination of the epoxy used to line the bottom stiffening ring on L6 (NE side, 2x10cm); partial delamination of the epoxy on bottom ring of L11 (bottom portion, south, 3cm deep x10 cm long); delamination of epoxy on bottom ring (2cm deep x15 cm long) of L10 was observed. A portion of the epoxy around the delamination area on L10 and L11 was ground and it was found that the delamination was only on the surface and did not affect the bonding of the ring in any way. The ground surface was filled with a new epoxy (Araldite AV3419/Hardner HV3419 supplied by CIBA-GEIGY). Figure 10 shows a view of delaminated epoxy and the ground surface. Some portions of the silicone sealant used between the two sections of downcomer pipes above the embedded parts looked defective (i.e. sections were out of position, easy to pull out) on L4, L8, L9, L11, L13 and L14. These sections were repaired by removing the old sealant, cleaning the surface, and recaulking with GEC RTV 102 (Figure 11). Downcomer L9 received both RTV 102 and RTV 108.

Thorough internal and external inspections including hardness measurements were carried out on downcomers L1, L2, L3, and L4. As in 1980, internal inspection was limited to the length from the upper vacuum chambers and the EWST floor. All four

downcomers were found in excellent condition with no evidence of degradation or cracking, both internally and externally. Hardness was measured between the floor of the EWST and the roof at approximately every 30cm (every 5cm at joints and rings) and found to be well above 20 on the Barcol scale. The hardness readings and corresponding pipe locations are given in Table I.

6.3 Risers

In addition to general visual inspection of all risers, a thorough internal and external inspection was conducted on L15, L16, L17, and L18. All risers (Figure 12) were found to be in good condition without any evidence of deterioration. Barcol hardness readings were found to be consistently high (Table II). The flanges and stiffening rings were also found to be in excellent condition except for L18 where partial delamination of the epoxy used to line the ring was found on the middle ring, middle portion, west side, 3cm deep and 12 cm long; on top ring, bottom sector, NW side and SSW side, 2 cm deep by 5 cm long. As in the case of the downcomers, this apparent delamination is only on the surface and does not affect the bonding of the rings.

6.4 Vacuum Pipes

Accessible areas of the vacuum pipes were visually inspected in the vacuum building basement, vacuum building main volume, EWST, and on the vacuum building roof. The hardness readings, taken at selected areas, were found to be in the range of 30 to 40 on the Barcol scale. In general the vacuum pipe from the basement to the EWST was found to be in excellent condition. Visual inspection of the pipes above the roof, one connecting to the east chamber and another connecting to the west chamber (Figure 13A and B), revealed a badly burnt section throughout the full length of the pipes as shown in Figure 13C. It appeared to be caused by a heating tape (approximately 4 inches wide) used to heat the pipe. However this heating tape was not present at the time of inspection. It appears that the 4 inch tape had been replaced, some time in the past, with a narrow heating tape as shown in Figure 13C. Closer inspection showed that the burnt area had all its resin charred and the fibers were exposed. The Barcol hardness was in the range of 60 to 70. Since there was no resin top coat left to protect the fibers it was recommended that the pipe from the roof to the vacuum chambers be replaced.

Because of the difficulty in procuring another FRP pipe replacement within the short time available it was replaced with a stainless steel pipe. During the installation of the steel pipe, the FRP flanges on both the pipes (east and west side) were damaged. The damage in the FRP flanges was noticed after a leak was detected during evacuation of the building.

Closer inspection of the flanges revealed several hairline cracks along the bolt holes, which propagated through the thickness of the flange, and also the epoxy used to bond the flange to the pipe was separated (Figure 14). It appears that the damage was caused by torquing of the steel flange to the FRP flange beyond the flange bond strength, causing the FRP flange to pull away from the bottom FRP pipe at the epoxy-FRP pipe bond. The damaged FRP flange was repaired as follows:

6.5 Repair of FRP Flanges

Preliminary inspection of the damaged flange did not show that the flange had separated from the pipe. It was thought that the hairline cracks present below the flange and around the bolt holes could be repaired using an epoxy and fiber glass cloth patch work. However, during the surface preparation for the patch work, the flange separated easily from the pipe because of the epoxy-pipe bond breakage (Figure 15). Therefore it was decided to replace the damaged flange with a flange removed from the top section of the burnt vacuum pipe. After carefully separating the damaged flange from the pipe, the surface was prepared by removing the old epoxy (appears to be Fibergrid's EPOXY F), grinding the outer and inner surface of the pipe, removing all the loose contamination, and cleaning with trichloroethane solvent. The flange from the burnt section of the pipe was cut and machined carefully. A new epoxy, Araldite AV3419/Hardner HV3419 supplied by CIBA-GEIGY, was applied to the inside surface of the flange, and outside surface of the pipe. The flange was inserted over the pipe with proper alignment of the bolt holes (the position of the bolt holes was marked before removing the damaged flange), and was left to cure for 12 hours making sure the flange stayed level. After 12 hours the excess epoxy on the inside and outside surface of the pipe was removed by hand wire brushing and a thin coat of Atlac 4010 resin was applied on the inside and outside surface of the pipe in addition to a layer of glass cloth (non woven mat, supplied by Fibergrid) on the outside. 12 hours later a second layer of glass cloth (non woven mat) was applied on the outside followed by a final resin (Atlac 4010) gel coat after 36 hours. Following the successful repair of the flange the vacuum building was evacuated to the design vacuum.

7.0 INSPECTION AFTER DOUSE TEST

Access was provided to the emergency water storage tank after the douse test. General visual inspection of the risers, downcomers, stiffening rings, and associated components from the floor of the EWST showed no signs of deterioration indicating the douse test had no damaging effect on the FRP system.

8.0 CONCLUSIONS AND RECOMMENDATIONS

The fiber-reinforced plastic components in the vacuum building at the Pickering NGS, which were placed in service 20 years ago, were found in good condition. The stiffening rings (Figure 16) installed during the 1980 outage were also in excellent condition including the epoxy used to line the ring sections to the risers and downcomers. The hardness readings of all the FRP components were high on the Barcol scale indicating no sign of deterioration.

It is recommended that the fill/drain line going into the spray header H1, where a minor leak was detected, should be reinspected to determine if the leak rate has increased. For the next inspection, downcomers and risers closer to the entrance (upper vacuum chambers) should be selected.

Approved by:

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Manager
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Chemist
Materials Chemistry Section

Reviewed by:

R.W. Glass
Supervising Chemist
Materials Chemistry Section

9.0 REFERENCES

1. "Pickering NGS 1990 Vacuum Building Outage - FRP Components Non-routine Inspection Results," CHRD Report No. C90-49-K, July, 1990.

2. "Pickering NGS 'A' Vacuum Building Inspection" D&D Report No. 80383, Dec 1980.

3. "Inspection Requirements for Fiber-Reinforced Plastic Components of the Pickering Vacuum Building" File: 907-NA44-34200P; 907-NK30-43200P; March 1990.

4. "Pickering Nuclear Generating Station, 1990 Station Outage, Vacuum Building and Pressure Relief Duct Inspection Program" PNGS CPS-N-200000004; April 20, 1990.

5. "Vacuum Building FRP Components", Inter Office Memo to R. Poulin from R. Rajagopalan and G. Gowda; May 18, 1990.

FIGURE 1: VACUUM BUILDING SPRAY SYSTEM - NORMAL CONDITION

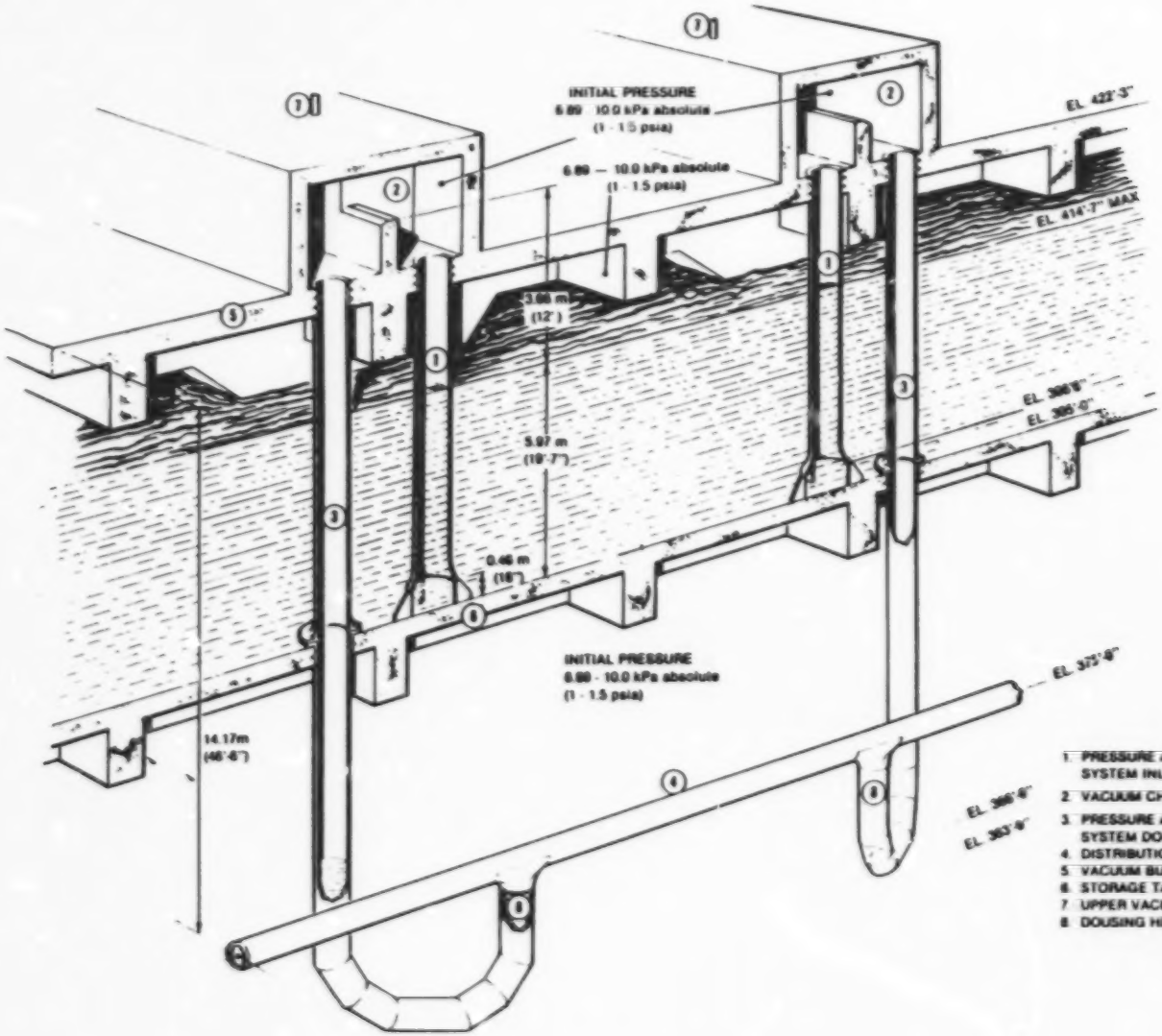


FIGURE 2: VACUUM BUILDING SPRAY SYSTEM - OPERATING CONDITION

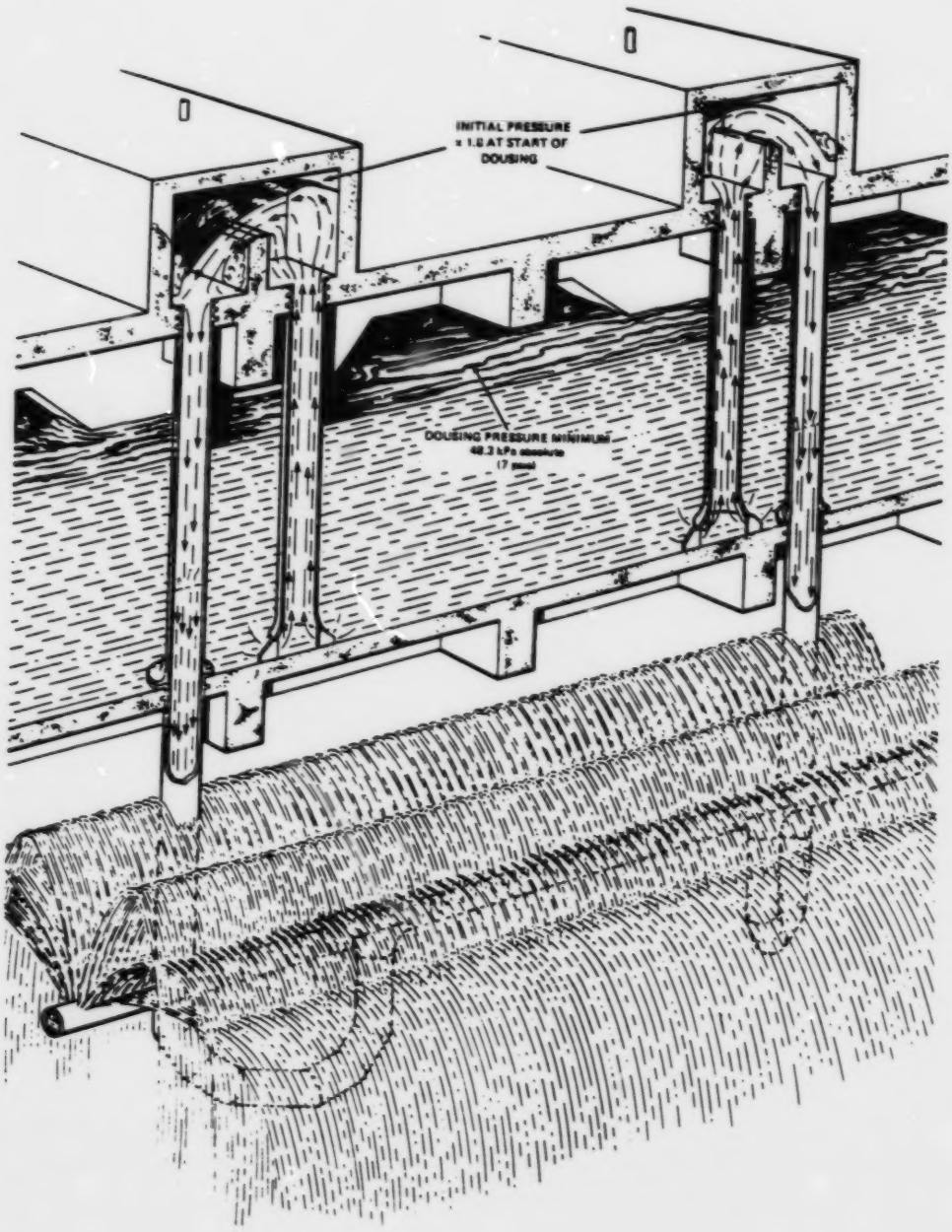


FIGURE 3: NUMBERING SYSTEM FOR RISERS (L15-L28), DOWNCOMERS (L1-L14) AND SPRAY HEADERS (H1-H7)

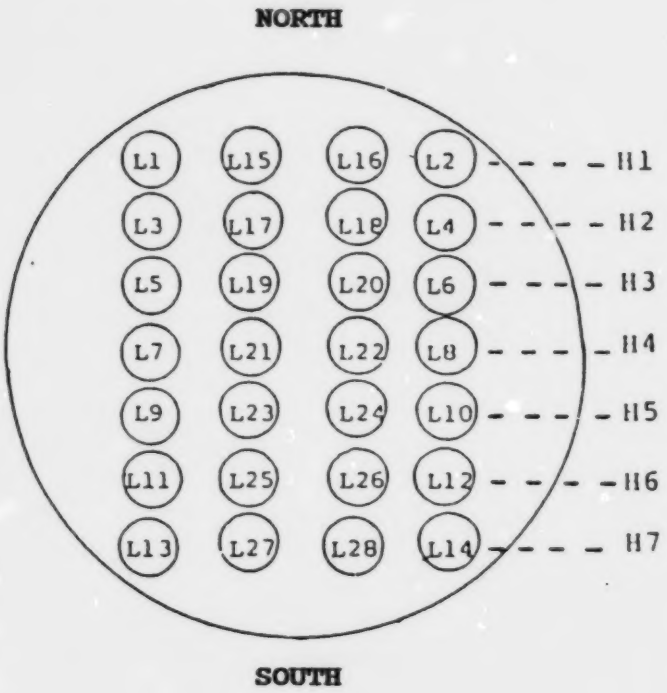


FIGURE 4: INFORMATION ON PULLEY/BOSUN'S CHAIR SET UP

03/30/1990 13:38 GRIP SAFETY&RESCUE S.INC. 364 P02 MAR 13 '90 11:0
416 660 1019 P.03

GRIP
Safety & Rescue Systems Inc.

8481 Keele Street Unit 1
Concord, Ontario L4K 2N2

Tel.: (416) 660-1030 Fax: 660-1019

Date: March 30, 1990

Mr. Ed Hurd
Ontario Hydro
Pickering N.G.S.
Pickering, Ontario
L1V 2R5

Dear Mr. Hurd:

It was a pleasure speaking with you recently regarding the Rollglide Rescue & Utility System. As requested, I have prepared the enclosed Rollglide quotation.

The Rollglide system will provide you with a lightweight, compact and easy to use system to raise, lower and safeguard yourself during entry into the areas we discussed, safely and with a minimum amount of equipment and manpower. The system can be anchored anywhere it is required in a matter of seconds, such as on a tripod or ceiling beam affording complete portability.

For your operation the operator will be able to lower himself into the area using the Rollglide and the harnesses you have, stop at a level with both hands free for inspection and then raise himself back up easily and safely. In the event that something happens to the person inside, a second person will be able to raise him to safety from the outside. The system should be ordered with enough rope for your deepest area. This requires 4.1 times the maximum depth encountered when someone will be raising and lowering themselves. If your deepest is 75 feet, then the system will be roped with 310 feet of rope. The standard carry/storage bag will hold up to 400 feet.

Thank you for your interest and I will speak to you soon to see if you have any questions.

Sincerely,
GRIP SAFETY & RESCUE SYSTEMS INC.

Greg Pickering
Application/Sales Engineer

FIGURE 4: continued

Safety & Rescue Systems Inc.
8481 Keele Street Unit 1
Concord, Ontario L4K 2B2
Tel.: (416) 669-1030 Fax: 669-1919

Date: March 30, 1990

QUOTATION

FOR: Mr. Ed Hurd
Ontario Hydro - Pickering N.G.S.

SYSTEM:	ROLLGLISS BR-1 RESCUE & UTILITY SYSTEM	
EQUIPMENT:	1 - Rollgliss Head Assembly 1 - 100 ft. length Rollgliss 9mm. Blue Dynamic Rope 1 - Upper Deflection Pulley, Installed 1 - Lower Traveller/Deflection Pulley, Installed 1 - Rope Control/Stopping Handle 1 - 4 ft. Handle Securing Rope w/eyes 2 - D-Ring Carabiner Snap Hooks 2 - Teardrop Carabiner Snap Hooks 1 - # 410 PVC Storage Bag	
PURCHASE PRICE:	Including complete equipment F.S.T. & P.S.T. extra where applicable	$ 1947.00
OPTIONAL EQUIPMENT:	# 10512 - 7 ft. Aluminum Tripod with adjustable height	$ 695.00
	# 323 - Extra Rollgliss Rope, any length	$ 2.33/f
TERMS:	Balance Net 30 days. Payment after 30 days is subject to service charge of 1.5% per month.	
WARRANTY:	Rollgliss systems are fully warranteed for a period of one year against all defects in materials and workmanship. No parts or labour will be charged during this period.	
DELIVERY:	2 weeks from receipt of order unless advised	

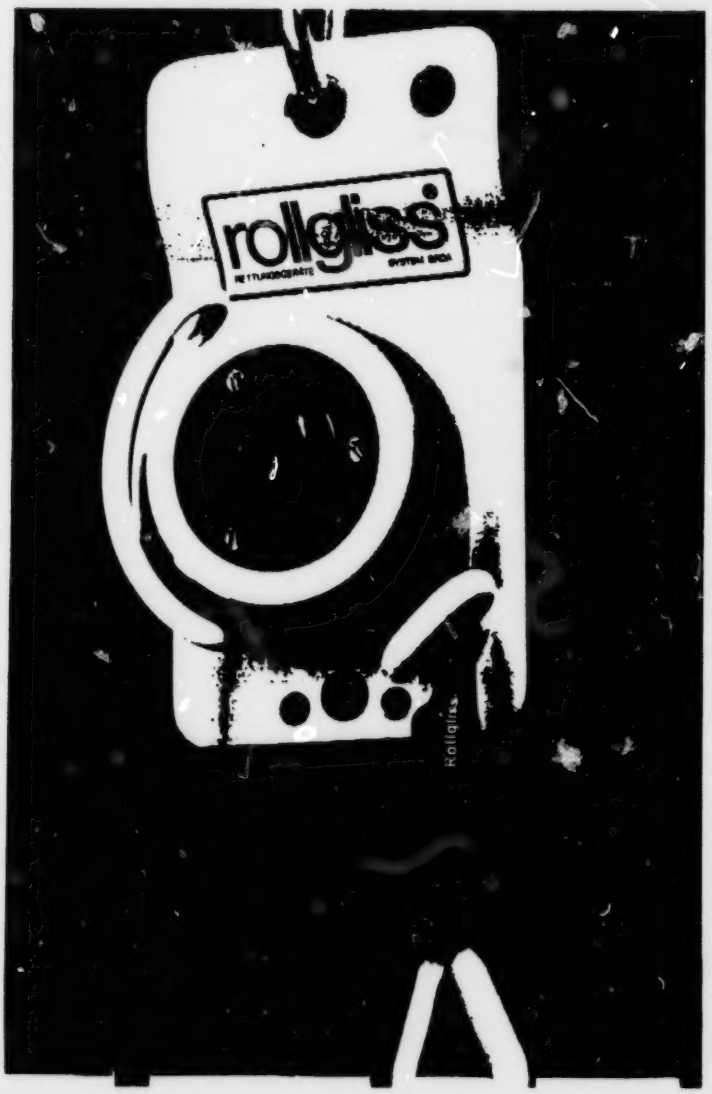
(E. & O. E.)

FIGURE 4: continued

364 P04 JUL 13 '90 11:05

ROLLGLISS

The Universal Rescue and Utility System



A life-saving rescue system...
A safe working tool for raising and lowering.

Internationally Patented

FIGURE 5: BOSUN'S CHAIR USED FOR INTERNAL INSPECTIONS

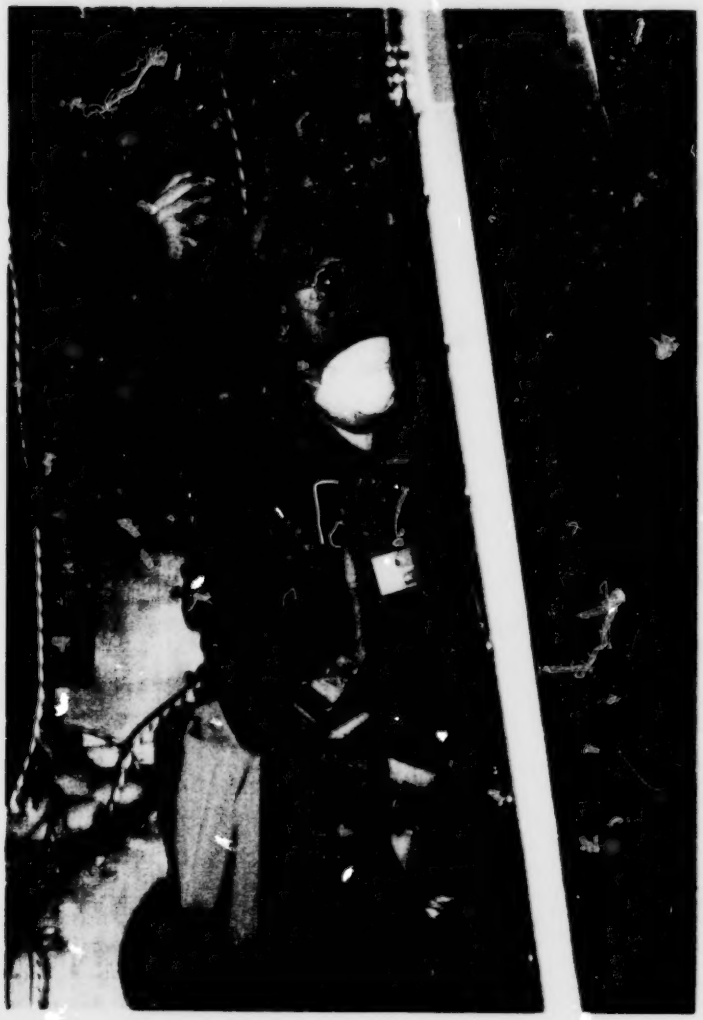


FIGURE 5:Continued

FIGURE 6: GENIE LIFT USED FOR EXTERNAL WORK

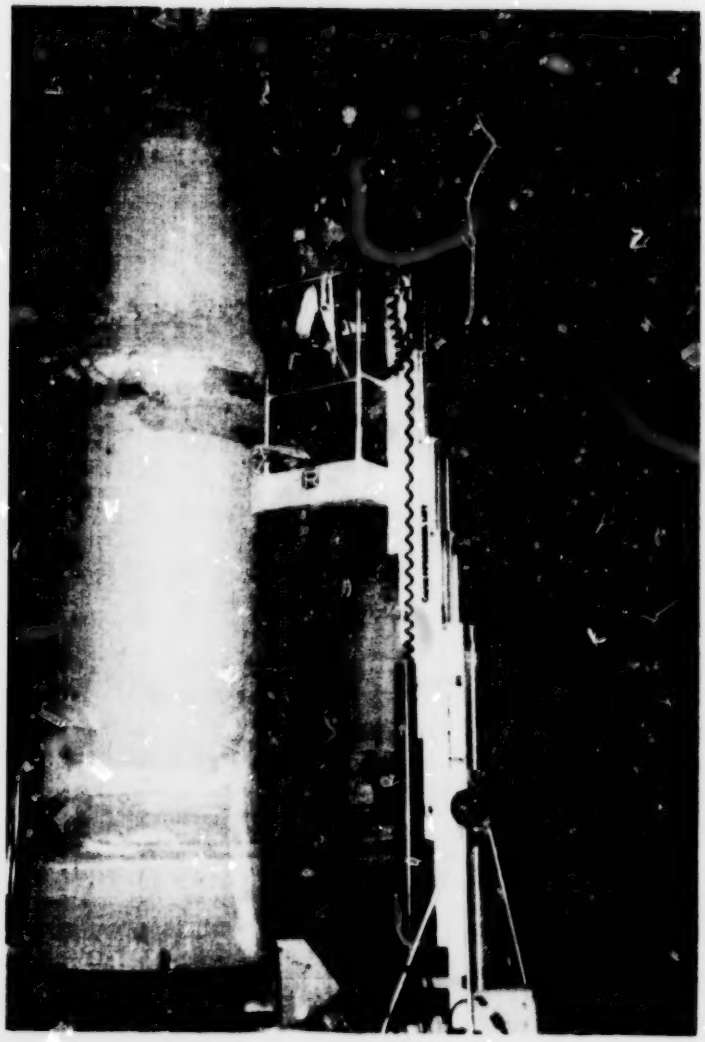


FIGURE 7: GENERAL VIEW OF THE EWST

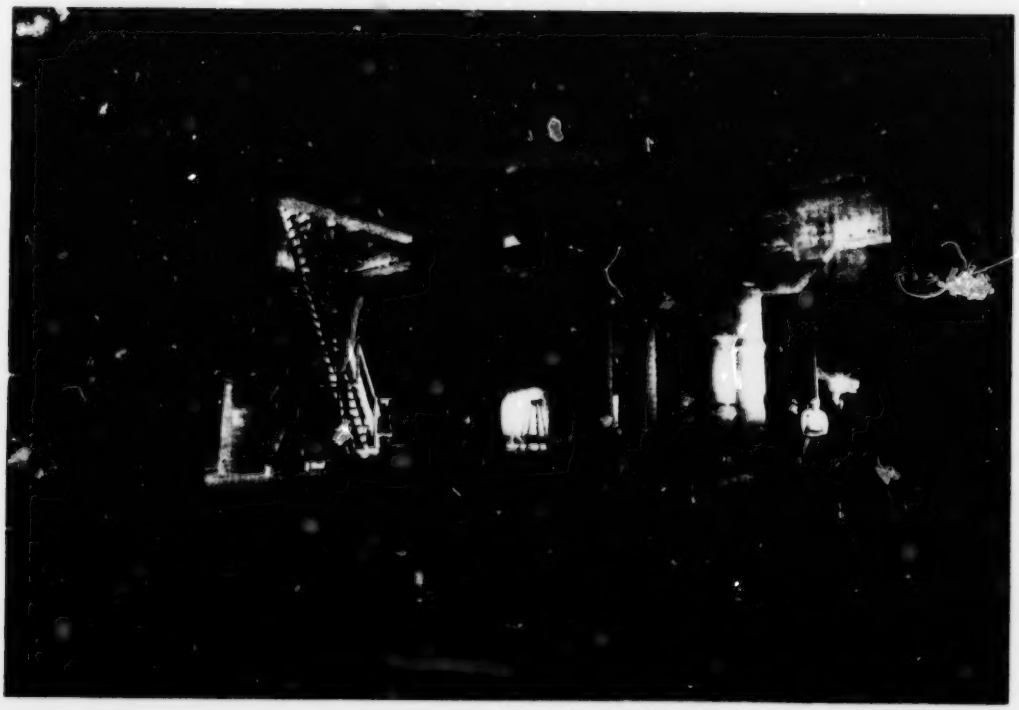


FIGURE 8: VIEW OF SPREAY HEADER AND WATER LINES

FIGURE 9: VIEW OF DOWNCOMRS IN EWST

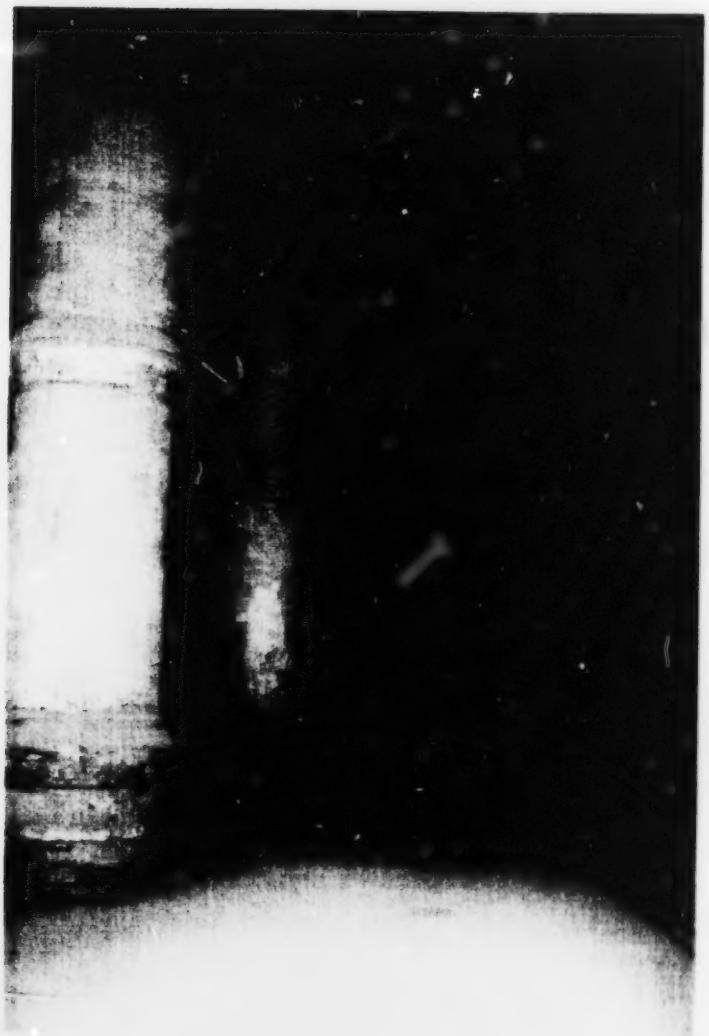


FIGURE 10: SURFACE DELAMINATION OF EPOXY AROUND THE STIFFENING RINGS

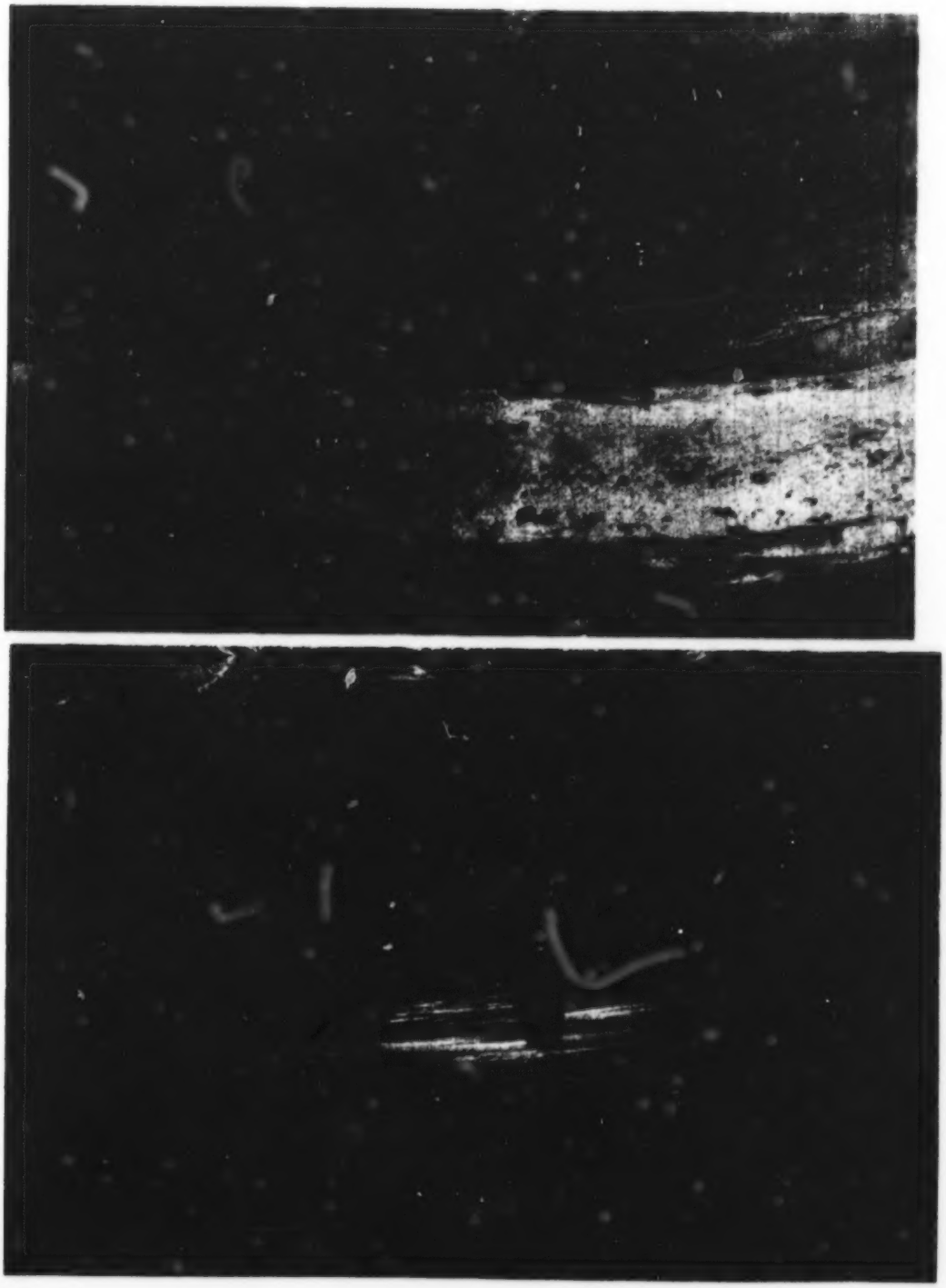


FIGURE 11: AS FOUND AND REPAIRED SILICONE SEALANT AND CAULKING AROUND A DOWNCOMER

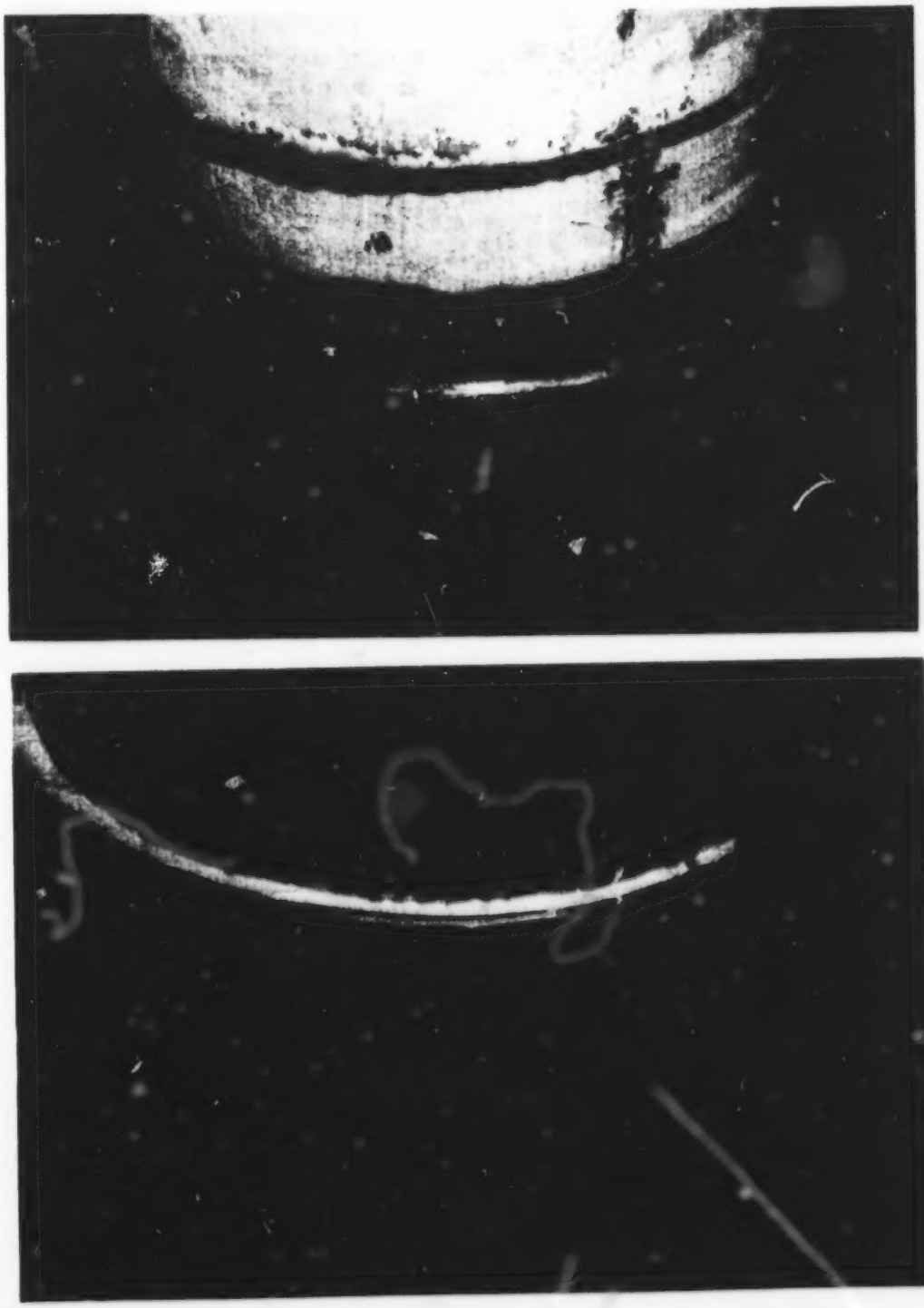


TABLE I

BARCOL HARDNESS OF DOWNCOMERS L1, L2, L3 & L4

Distance From EWST Floor (m)	L1		L2		L3		L4	
	In	OUT	IN	OUT	IN	OUT	In	OUT
0.3	30	29	31	25	40	33	47	25
0.6	35	24	42	36	40	32	50	37
0.9	38	27	38	34	40	35	40	33
1.2	40	34	38	24	40	35	43	28
1.5	32	32	37	28	40	32	40	30
1.8	38	28	38	30	39	31	46	35
2.1	35	35	39	28	40	33	40	31
2.4	35	28	38	32	40	33	41	32
2.7	35	27	37	30	40	32	46	35
3.0	32	27	35	30	42	34	42	32
3.3	32	24	39	25	39	30	35	30
3.6	30	27	38	30	40	32	45	32
3.9	32	25	40	30	40	28	39	32
4.2	37	27	48	30	40	24	42	32
4.5	35	28	45	30	35	24	42	32
4.8	35	28	40	30	30	31	42	28
5.1	38	26	38	30	36	22	39	27
5.4	36	31	38	30	35	28	40	30
5.7	34	28	41	32	38	25	36	30
6.0	36	23	48	30	40	30	41	40
6.3	40	33	42	30	41	28	39	38
6.6	35	36	42	30	40	30	43	
6.9	35	32	40	30	40	26	35	
7.2					40	27		

Barcol Hardness of Associated Components:

L1, flange in vacuum chamber: 45
L2, bottom ring : 28-38
L3, flange in vacuum chamber: 38
L4, flange in vacuum chamber: 40
bottom ring : 38-39
joint at 4.8 meters : 22-24-25-25-30
joint at 5.1 meters : 25-23-30-30-22
L12 bottom ring : 40-42
flange in EWST : 30
L14 bottom ring : 32-40
flange in EWST : 40

FIGURE 12: VIEW OF RISERS IN EWST

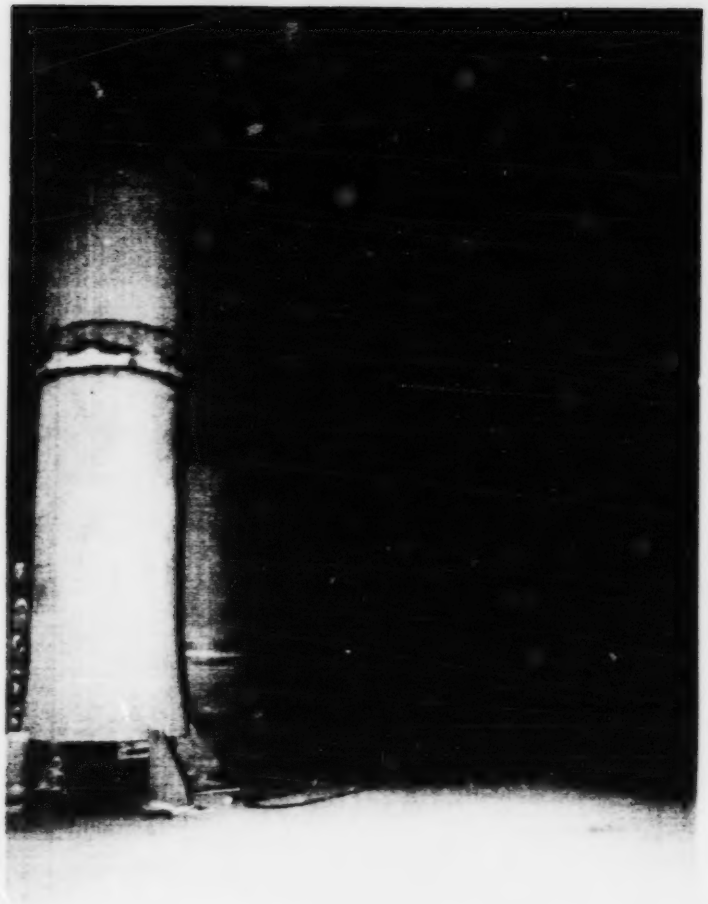


TABLE II

BARCOL HARDNESS OF RISERS L15, L16, L17 and L18

Distance From EWST Floor (m)	L15		L16		L17		L18	
	In	OUT	IN	OUT	IN	OUT	In	OUT
0.6096	40	35	30	27	30	30	30	28
0.9096	30	28	30	31	28	25	30	22
1.2096	25	29	30	30	30	30	30	30
1.5096	30	32	30	30	28	36	28	30
1.8096	30	31	28	30	28	39	34	30
2.1096	28	29	37	30	26	37	33	30
2.4096	28	37	30	31	29	34	33	30
2.7096	30	35	35	35	29	35	29	30
3.0096	30	34	30	28	28	36	30	25
3.3096	30	38	29	35	28	25	31	29
3.6096	30	35	35	30	30	39	32	22
3.9096	30	32	34	32	29	32	30	30
4.2096	30	27	35	35	26	33	28	30
4.5096	28	37	34	30	28	35	30	32
4.8096	22	30	29	38	33	37	35	28
5.1096	30	30	38	30	30	29	30	35
5.4096	30	32	30	28	30	33	25	35
5.7096	28	34	30	32	30	36	35	30
6.0096	30	33	28	30	35	34	36	30
6.3096	30	40	28	33	32	36	38	30
6.6096	30	37	27	30	33	35	40	30
6.9096	30	32	33	27	30	35	37	30
7.2096	32	35			30	34	37	30
7.5096	32	35			30	32		

Barcol Hardness of Associated Components:

L15, bottom ring :30-38
flange in vac chamb :42
L16, middle ring :30-30
joint at 4.2096 meters:32-34-34-30-38
joint at 4.5096 meters:38-32-28-32
L17 bottom ring :20-35
flange in vac chamb :45

FIGURE 13A: WEST CHAMBER VACUUM PIPE WITH FRP FLANGES AND INSULATION INTACT

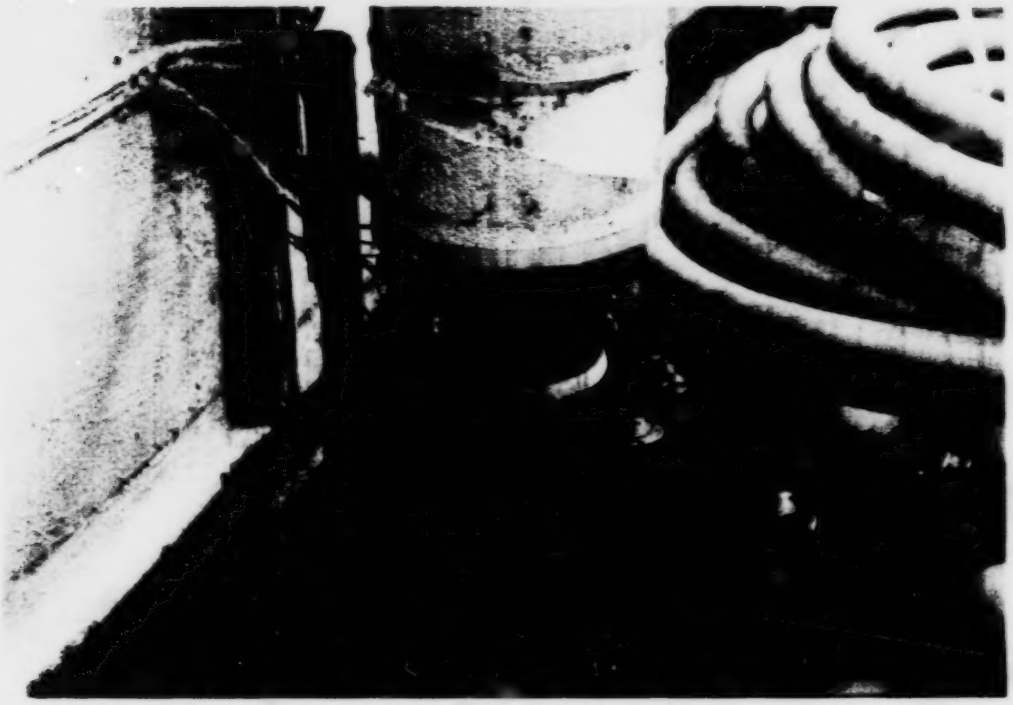


FIGURE 13B: EAST CHAMBER VACUUM PIPE WITHOUT INSULATION

FIGURE 13C: VIEW OF BURNT VACUUM PIPE

FIGURE 14: DAMAGED FRP FLANGE

FIGURE 14: Continued

FIGURE 15: REPAIR OF FRP FLANGE

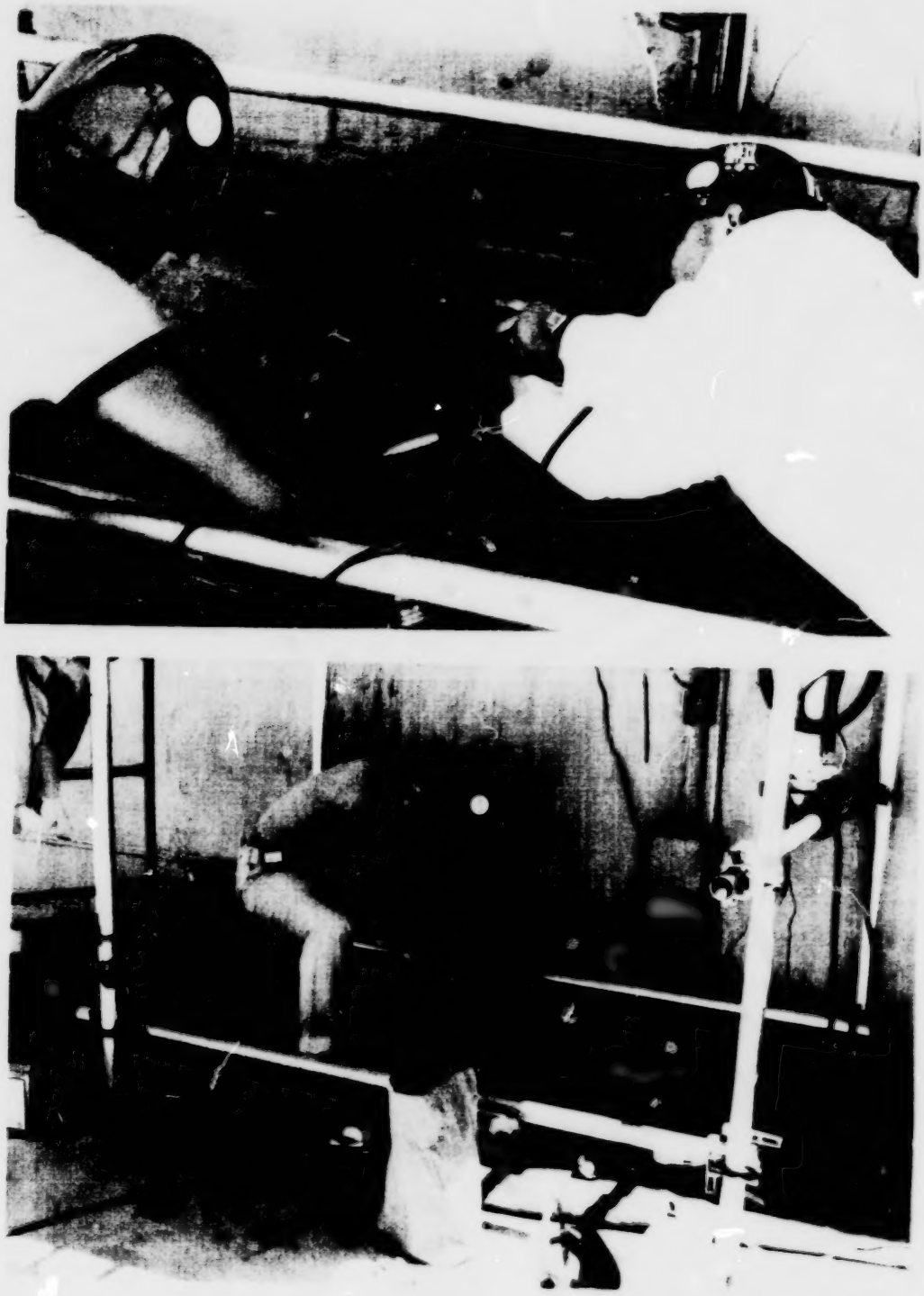


FIGURE 15: Continued

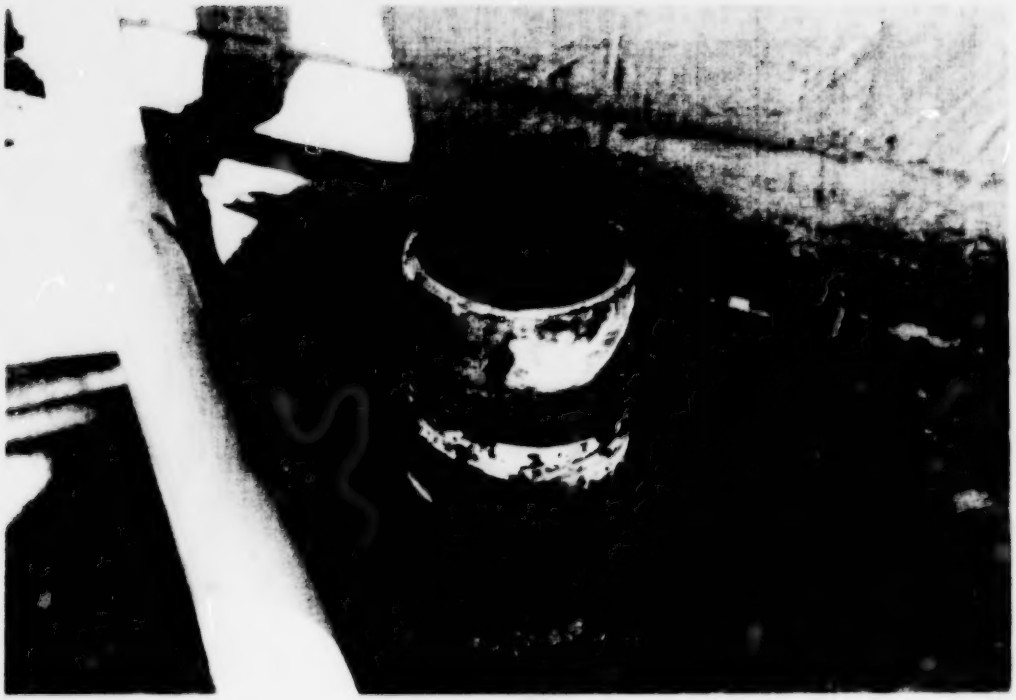


FIGURE 16: VIEW OF FRP STIFFENING RINGS